

BANK TRENDS

ANALYSIS OF EMERGING RISKS IN BANKING

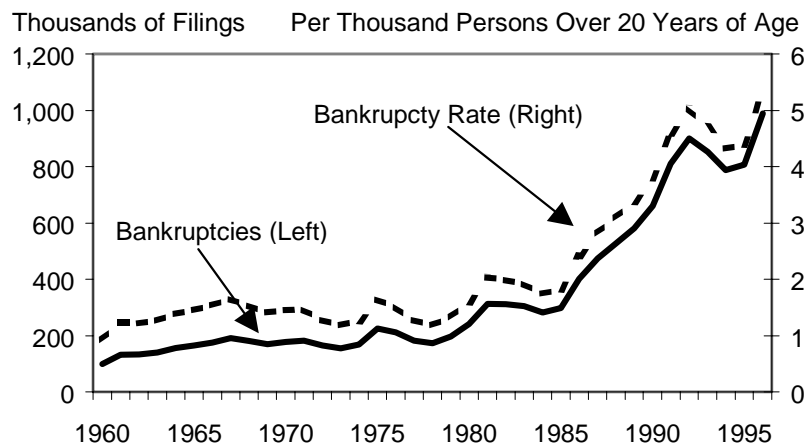
WASHINGTON, D.C.

PAUL C. BISHOP
(202) 898-3651
pbishop@fdic.gov

A Time Series Model of the U.S. Personal Bankruptcy Rate

The annual number of personal bankruptcy filings has risen from less than 200,000 in 1978 to more than one million in 1996. More recent data show that the number of personal bankruptcies continues to increase. This paper presents an overview of the U.S. personal bankruptcy rate and shows that two types of economic indicators are important in explaining it: consumer indebtedness and business cycle activity. A model is developed to estimate the influence of each of these factors on the time series behavior of the bankruptcy rate. The time series model shows that approximately two-thirds of the increase in bankruptcies can be explained by these two factors alone. An out-of-sample forecast is also performed to judge the adequacy of the proposed model. While the actual bankruptcy rate has risen higher than expected, the out-of-sample forecast suggests that a large share of the sharp upward trend in bankruptcies in the late 1980s and early 1990s can be explained by consumer indebtedness and business cycle activity. The share of the increase that remains unexplained in the model may be attributable to changes in other demographic or social factors.

Bankruptcies Rose Rapidly After 1985



Source: Administrative Office of the U.S. Courts

A Time Series Model of the U.S. Personal Bankruptcy Rate

The annual number of personal bankruptcy filings has risen from less than 200,000 in 1978 to more than one million in 1996. More recent data show that the number of personal bankruptcies continues to increase. The number of bankruptcies in the second quarter of 1997 was 25 percent higher than the number in the second quarter of 1996, pushing the annualized filing rate to more than 1.4 million. Of particular concern is the fact that the growth in bankruptcies has continued unimpeded even during the economic expansion that started in 1991. Apparently, factors other than the performance of the national economy have been contributing to the increase.

Popular speculation suggests many reasons for the increase in bankruptcies since the mid-1980s. Among the reasons often cited are high consumer debt burdens resulting from excessive credit-card debt, changes in the legal environment — especially in relation to the bankruptcy code — and the loss of social stigma when a household files for bankruptcy protection. Changes in the nation's demographic characteristics have also been suggested, including a rise in the number of single-parent households, lack of medical insurance, and changing patterns of wealth and debt accumulation by the large cohort of baby boomers reaching 50 years of age. Whatever the primary causes, it is clear from the discussion in the press and elsewhere that the number of bankruptcies continues to be much higher than most analysts expected.

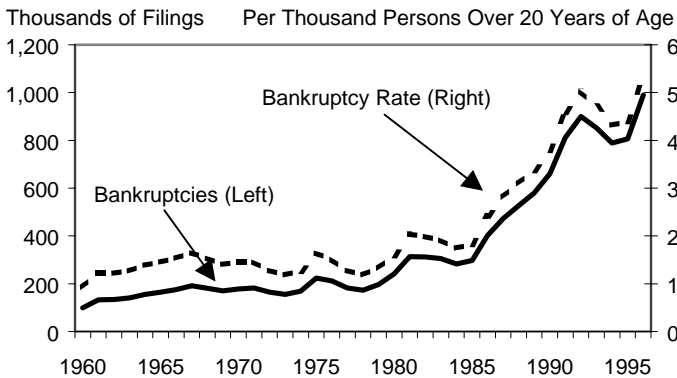
The purpose of this paper is to determine, econometrically, the influence of measurable economic factors on the national bankruptcy rate. Examining measures of consumer indebtedness and the business cycle over a long period of time — 1960 to the present — may explain much of the rise in the

national bankruptcy rate. Although this approach is not based on a theoretical model of a household's decision to file a bankruptcy petition, abstracting from this microeconomic level of detail has the advantage of showing the extent to which certain key economic indicators may influence the bankruptcy rate. Additionally, if the relationship between consumer indebtedness and the bankruptcy rate is more clearly defined it may be possible to form more reasonable and accurate expectations about the likely rate of bankruptcy filing in the future.

The first section of this paper reviews the relationship between the commercial bank consumer loan charge-off rate and the bankruptcy rate as a motivation for further study of the bankruptcy issue. The second section reviews a few measures of consumer indebtedness as background for the model. The third section posits a model of the bankruptcy rate based on measures of consumer indebtedness and the business cycle. The final section discusses possible additional factors in the unexpected rise in bankruptcies during the past few years.

U.S. Personal Bankruptcies and Consumer Loan Charge-Offs

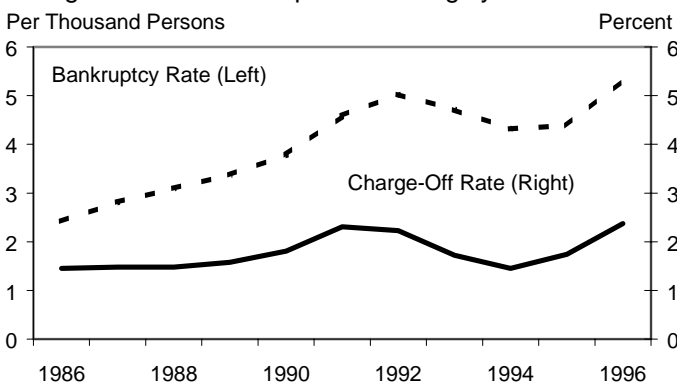
Chart 1 shows the number of personal bankruptcies and the bankruptcy rate as measured by the number of bankruptcies per thousand persons over 20 years of age.¹ The most notable feature is the sharp increase since the mid-1980s. Not only has the bankruptcy rate risen to an unprecedented level, but the increase has been relatively swift and steady. Since such a trend has never occurred before, analysts have sought both to explain the increase and to determine the consequences of such a significant change in the financial performance of a large number of U.S. households.

Chart 1**Bankruptcies Rose Rapidly After 1985**

Source: Administrative Office of the U.S. Courts

A rising bankruptcy rate may have a detrimental impact on commercial bank consumer loan charge-offs, for example. Consumer loan charge-off rates of commercial banks have increased dramatically since early 1995, as shown in Chart 2. Charge-off rates have risen from a cyclical trough of 1.45 percent of outstanding loan balances in 1994 to 2.37 percent in 1996. The charge-off rate is very cyclical, as evidenced by the fact that the current rate has surpassed the last peak of 2.31 percent reached in 1992. Since the data do not extend back before the mid-1980s, it is difficult to determine if the current charge-off rate is atypical since only one recession and part of the previous 1980s expansion are reflected in the data. Also shown in Chart 2 is the bankruptcy rate. Clearly, there is a close correlation between changes in the bankruptcy rate and changes in the charge-off rate.

The correlation coefficient between the charge-off rate and the bankruptcy rate is shown in Table 1 for

Chart 2**Charge-Offs and Bankruptcies Are Highly Correlated**

Source: Administrative Office of the U.S. Courts and Federal Reserve Board

both quarterly and annual frequency data. Two correlation coefficients have been computed for each data periodicity. The correlation coefficients between the levels of the data show the closeness of the relationship between the bankruptcy rate and charge-off rate, including the trend component associated with many economic time series. Since a highly positive correlation between the levels of two economic time series is not unusual, it is also advisable to compute the correlation between the period-to-period changes in the two series. Again, the correlation coefficients in this case show a large positive correlation, meaning that a strong relationship exists between the period-to-period changes in each series and not just in the trend-driven levels of each series. Since the bankruptcy rate and the charge-off rate are highly correlated, it is reasonable to conclude that an expectation of continued increases in the bankruptcy rate will also be reflected in a rise in the charge-off rate.²

Table 1**Charge-Off Rate and Bankruptcy Rate Are Highly Correlated**

Correlation Coefficient at Different Periodicities

Quarterly Data (1990:4 - 1997:1)	
Levels	0.775
Quarterly Change	0.645
Annual Data (1986-1996)	
Levels	0.785
Annual Change	0.853

Consumer Indebtedness

Table 2 illustrates the compound annual growth rate of outstanding consumer loan balances over the period from 1979 to 1996 and four subperiods: 1979 to 1982, which roughly coincides with the recessionary period during the early 1980s; 1982 to 1990, which includes the 1980s expansion; 1990 to 1992, which reflects the contraction in consumer credit during and immediately after the early 1990s recession; and 1992 to 1996, which covers the current economic expansion. Growth rates by credit holder are shown for auto loans, revolving credit and other (noninstallment credit, mobile home loans, and loans for education, boats, vacations, and all other consumer credit not included in auto or revolving

Table 2**Consumer Credit by Holder and Credit Type Varies Over Business Cycle**

(compound annual growth, percent)

	Contraction 1979-1982	Expansion 1982-1990	Contraction 1990-1992	Expansion 1992-1996	1979-1996
TOTAL	2.5	10.4	-0.5	11.2	7.8
Automobile	4.3	10.5	-4.4	10.2	7.4
Revolving	7.4	16.3	7.4	15.7	13.5
Other	-0.5	7.1	-3.6	7.1	4.4

Source: Federal Reserve Board of Governors

balances). Over the period from 1979 to 1996, consumer credit increased at a compound annual rate of 7.8 percent, although the growth varied during expansions and contractions. From 1992 to 1996, the compound annual growth rate of loan balances was 11.2 percent.

The rise in consumer loan balances is meaningful only if placed in the context of the ability of the consumer to repay the debt. One measure of the consumer debt burden is debt service as a percentage of disposable personal income. Debt service is the total of principal and interest payments. In contrast to the often-quoted debt-to-income ratio, the debt service burden is a truer measure of the ongoing financial obligations that households face. Because the debt service burden measure implicitly is influenced by interest rates, it captures underlying household financial dynamics more fully than the debt-to-income ratio. From a household perspective, the impact of greater debt accumulation is determined not by the aggregate level of debt, but by the financial commitments necessary to meet the repayment schedule (i.e. the debt service).³

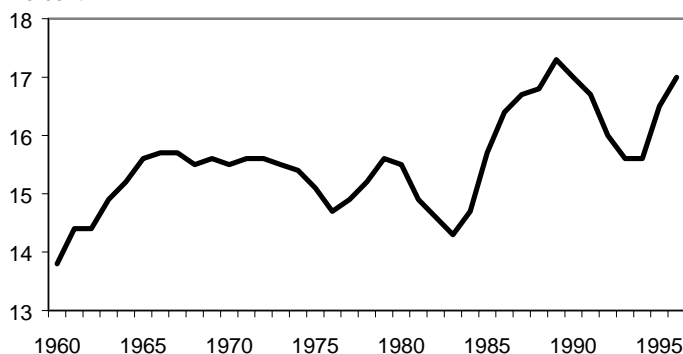
Chart 3 shows the total consumer debt service burden which is the sum of consumer credit and mortgage debt service burdens. Although the total debt service burden has not yet risen above the late 1980s peak, it is clearly not far from surpassing that peak.

Coincident with the long-term increase in consumer debt service burden, the composition of consumer debt has also changed significantly during the past 30 years. As a share of disposable income, consumer credit debt service decreased from nearly 12 percent in 1970 to about 9 percent in 1983 (see Chart 4). It then rose dramatically during the 1980s expansion to just under 11 percent. Although the early 1990s recession caused another decrease, the consumer credit debt service burden has since grown to more than 11 percent — a level not seen since the mid-1970s.

The mortgage debt service burden, also shown in Chart 4, has taken a fundamentally different path. Rising steadily through the 1970s and 1980s, the mortgage debt service burden declined sharply in the early 1990s after the fall in mortgage interest rates.

Chart 3**Total Consumer Debt Service Burden Is Trending Up**

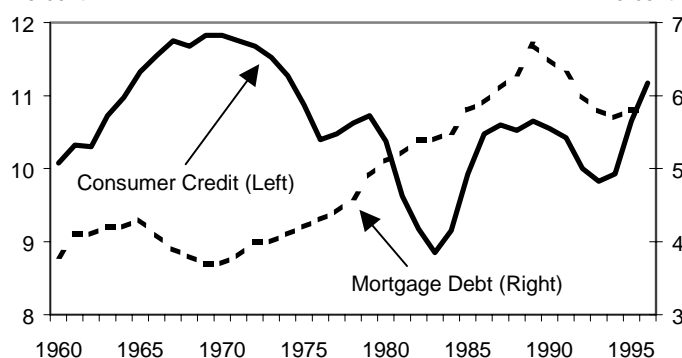
Percent



Source: Federal Reserve Board

Chart 4**Consumer Credit Debt Service Rises Sharply in 1990s**

Percent



Source: Federal Reserve Board

Although during the past two years the mortgage debt service burden has increased, it is still about one percentage point below the late 1980s peak.

Although the debt service burden may be rising in the aggregate, debt and the debt burden are not evenly distributed across the population. Generally, younger households are more likely to hold some type of debt, and the size of the outstanding debt they hold is likely to be greater. In terms of financial risk, younger households may be at greater risk of financial distress than older households. First, younger households have a greater demand for housing and consumer durables in the early years as they build up the stock of household capital. Second, these households generally have a smaller stock of wealth on which to rely if financial distress occurs. Supporting evidence relating to the burden of debt by age of householder is available from the Federal Reserve's 1995 Survey of Consumer Finances.⁴ According to the survey (see Table 3), more than 87 percent of households headed by a person between the ages of 35 and 44 had some type of debt, with more than one-half having credit-card debt and only slightly fewer holding mortgage and home equity debt. Among households headed by someone between 45 and 54 years of age, more than 86 percent held some type of debt, with 57 percent reporting some credit-card debt and nearly 62 percent holding mortgage and home equity debt. The median value of household debt holdings was highest in the

45-to-54-year age group at \$41,000. The 35-to-44-year age group ranked second and had a median debt holding of more than \$37,000. Outside of these two age cohorts, median household debt decreased dramatically. Table 3 shows the distribution of debt by age of householder.⁵

A Model of the U.S. Personal Bankruptcy Rate

Factors Influencing the U.S. Personal Bankruptcy Rate

Numerous factors are often cited as important influences on changes in the national bankruptcy rate. Among the most persuasive factors are consumer indebtedness and business cycle influences. As discussed previously, numerous demographic factors (e.g. age of head of household) may influence the incidence of bankruptcy. Although some of these other influences can be captured in an econometric model, the purpose of this paper is to determine to what extent consumer indebtedness and the business cycle explain the national bankruptcy rate.

- **Consumer Indebtedness** The burden of consumer indebtedness is the most intuitive explanation of why bankruptcies have risen so quickly since the mid-1980s. Some consumers have increased the potential risk of bankruptcy by

Table 3

Debt Holdings Vary by Age of Household Head

1995 Survey of Consumer Finances

Age of Head	Mortgage and Home Equity	Installment	Other Lines of Credit	Credit Card	Investment Real Estate	Other Debt	Any Debt
Percentage of Families Holding Debt							
Less than 35 years	32.9	62.2	2.6	55.4	2.6	7.8	83.8
35-44 years	54.1	60.7	2.2	55.8	6.5	11.1	87.2
45-54 years	61.9	54.0	2.3	57.3	10.4	14.1	86.5
55-64 years	45.8	36.0	1.4	46.4	12.5	7.5	75.2
65-74 years	24.8	16.7	1.3	31.3	5.0	5.5	54.5
75 years and over	7.1	9.6	**	18.3	1.5	3.6	30.1
Median Value of Holdings for Families Holding Debt (1995 dollars, thousands)							
Less than 35 years	63.0	7.0	1.4	1.4	22.8	1.5	15.2
35-44 years	60.0	5.6	2.0	1.8	30.0	1.7	37.6
45-54 years	48.0	7.0	5.7	2.0	28.1	2.5	41.0
55-64 years	36.0	5.9	3.5	1.3	26.0	4.0	25.8
65-74 years	19.0	4.9	3.8	0.8	36.0	2.0	7.7
75 years and over	15.9	3.9	**	0.4	8.0	3.0	2.0

Source: Federal Reserve Board of Governors

** Less than 0.05 percent of the group

becoming financially overextended. Although the specific economic and demographic characteristics of filers are unknown, the Federal Reserve's 1995 Survey of Consumer Finances provides some information about the increasing debt burden of lower-income households. For example, the share of households that have income of less than \$10,000 and hold some credit-card debt has more than doubled, from approximately 11 percent in 1989 to more than 25 percent in 1995. For higher-income households, the share of households with credit-card debt also is generally higher, but there has been a much less pronounced increase over the same period. Lower-income households are much more at risk of financial distress as well. Data from the Fed's 1995 Survey of Consumer Finances also shows that among households with incomes of \$10,000 or less, more than one-fourth have a debt service burden of at least 40 percent of disposable income. Nearly 17 percent of households with incomes of \$10,000 to \$25,000 have a debt service burden of at least 40 percent. Among all households, 11 percent have a debt service burden of 40 percent or more. In light of evidence of increasing debt burdens among households most at risk of financial distress, it would be difficult to make a strong case that rising indebtedness does not have some measurable influence on the rate of bankruptcy filing.

- **Business Cycle Activity** The influence of the national economy is important in determining the current and future financial prospects of households. Rising credit-card indebtedness, for example, is one of the possible secular changes in consumer behavior, while the cyclical performance of the economy has a more direct influence on the near-term financial strength of households. During recessions, the likelihood of severe financial distress increases, leading to a greater probability of any particular household filing for bankruptcy. Conversely, an economic expansion results in more fully employed resources, including labor, and brings with it the potential for more rapid income growth and a smaller likelihood of unmanageable financial distress.

The Data

To complete the model specification, it is necessary to select a set of explanatory variables that can be used in the estimation process to capture the major attributes of each of the factors cited above. Selecting data series is, to a large extent, an arbitrary process governed by both data availability and the specific characteristics of the data series themselves (series length, periodicity, etc.). Based on these considerations, the following indicators were chosen to complete the model specification:

- **Consumer Indebtedness**

CONSDEBT = consumer credit debt service burden (Source: Federal Reserve Board)

MTGDEBT = mortgage debt service burden (Source: Federal Reserve Board)

There are several indicators that could be used to measure household indebtedness. As suggested previously, the Federal Reserve's debt service burden series incorporates both changes in debt and the impact of interest rates on the burden of debt. Because the consumer credit and mortgage debt service burdens place indebtedness in the context of ability to pay, these two series were used in the estimation rather than alternative measures such as the debt-to-income measure of indebtedness. (The characteristics of these data series have been described in the previous section.)

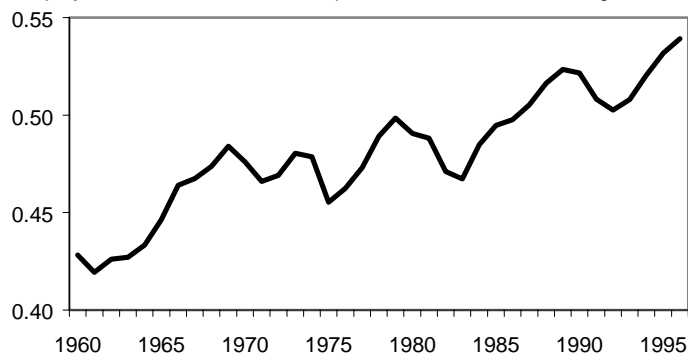
- **Business Cycle Activity**

EMPLOY = private nonfarm employment as a share of population over age 20 (Source: Bureau of Labor Statistics)

There are many time series that could be used to summarize the business cycle performance of the economy. Given its direct connection to the household sector through income growth, private employment tracks the business cycle as it directly affects households and not via a more indirect effect through other business cycle indicators such as gross domestic product (GDP) or industrial production. As shown in Chart 5, the cyclical pattern of the economy as a whole is reflected in private nonfarm employment relative to population over age 20.

Chart 5

Private Nonfarm Employment Tracks Business Cycle
Employment Share Relative to Population Over 20 Years of Age



Source: Bureau of Labor Statistics and Bureau of Economic Analysis

The data used in the estimation of the model are of annual frequency over the period 1960 through 1996.⁶

Estimation Results

The following equation was estimated using least squares:⁷

$$\text{BRUPT}_t = \text{Constant} + \beta_1(\text{CONSDEBT}_{t-1}) + \beta_2(\text{MTGDEBT}_{t-2}) + \beta_3(\text{EMPLOY}_t) + u_t$$

where

BRUPT = bankruptcies per thousand population over age 20

CONSDEBT = consumer credit debt service burden

MTGDEBT = mortgage debt service burden

EMPLOY = private nonfarm employment as a share of population over age 20

Subscript t is an index of time and u_t is the error term.

The dependent and independent variables were transformed using log differences to account for both nonstationarity and apparent heteroskedasticity of the errors when only differenced variables were used.⁸ The log-difference transformation also has the interpretation of modeling growth rates with coefficients interpreted as elasticities. Therefore, throughout the following discussion, the estimation results should be interpreted as the impact of various factors on the *growth* of the bankruptcy rate.

Table 4 shows the coefficient estimates, standard errors, t-statistics, and the lags placed on the independent variables.⁹

Interpretation of Results

The estimation results suggest that there is a strong relationship between consumer debt service burden and the bankruptcy rate. The consumer credit portion of the debt service burden measure is highly significant, with an elasticity of approximately 2.42. Given that this analysis has been done at an aggregate level, this result does not preclude a significant change in consumers' propensity to enter bankruptcy as a result of changes in a particular state's bankruptcy laws. To the extent that these local changes have occurred, the current model would not be influenced by such changes unless they occurred in several states at about the same time. The mortgage debt portion of the debt service burden variable is also significant but exerts a much smaller influence on bankruptcies, with an estimated elasticity of 1.10. Additionally, the impact of the mortgage debt service burden is delayed by two periods. All else being equal, a sharp rise in mortgage debt service will have a smaller and more delayed influence on bankruptcies than an equivalent increase in the consumer credit debt service burden.

Private employment growth has the expected impact on the bankruptcy rate, with an elasticity of -3.30. Rising employment, for example, serves as a proxy for a growing economy, conditions under which one would expect to see fewer bankruptcies.

A more revealing way to describe the influence of each of the explanatory variables is to translate the estimated coefficients on each of the estimates in the

Table 4

Estimation Results

37 Periods, Annual (1960-1996)
Dependent Variable = BRUPT

Variable	Lag	Coefficient	Std. Error	t-Stat
CONSDEBT	1	2.4198	0.2779	8.706
MTGDEBT	2	1.1041	0.3952	2.794
EMPLOY	---	-3.2989	0.6317	-5.222
Constant	---	0.0508	0.0142	3.570
Adj R-square		F-statistic	D.W. Statistic	
0.6868		21.9320	1.5612	

time series regression equation from elasticities to their impact on the *number* of bankruptcies rather than the *growth* of the bankruptcy rate. Table 5 shows the impact of a one standard deviation increase in each explanatory variable, assuming that all of the remaining variables are held constant. The standard deviation is used as the unit of measure since the relative size of the coefficient on an explanatory variable says little about the variability of the data itself. As shown in Table 5, the consumer credit debt service burden (**CONSDEBT**) has a greater standard deviation than private employment (**EMPLOY**) over the period from 1960 to 1996. Thus, to compare the impact of each explanatory variable on the number of bankruptcies, some measure of the size of the expected movements in the explanatory variable is needed. The standard deviation is one measure that allows a comparison across data with differing variability. Since the estimated model is nonlinear in the levels of each series, the impact of a change in any of the explanatory variables is measured relative to the 1996 value for that particular variable. For example, the change in the number of bankruptcies as a result of a one standard deviation increase in the consumer credit debt service burden (from 11.175 to 11.954) is 166,868, based on the estimated model.

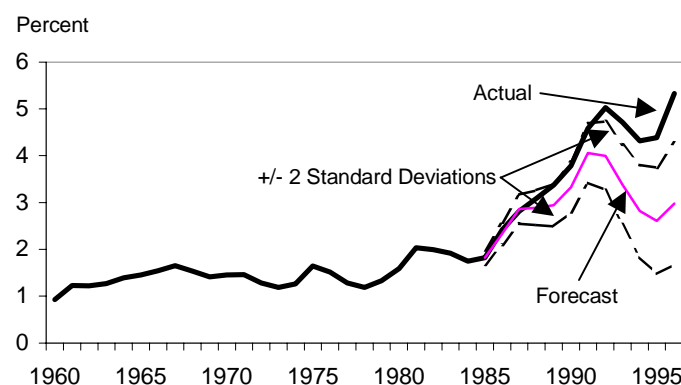
Forecast Accuracy

To evaluate the explanatory power of the model, an out-of-sample forecast was performed over the period from 1986 to 1996, which coincides with the period during which the bankruptcy rate nearly tripled. The goal of this exercise is to see how well the model would have performed given perfect knowledge about the future values of the explanatory variables.¹⁰

Chart 6 shows the actual and forecast values of the bankruptcy rate, as well as bands two standard deviations above and below the forecast values. One

Chart 6

Forecast of Bankruptcy Rate Underpredicts Actual Rate



of the most interesting features of the forecast is that it closely tracked the actual rise in bankruptcies through the early 1990s before diverging from the actuals. Even in 1991, the difference between the actual rate and the forecast was relatively small. Given the rise in consumer debt service burden and the impact of the recession on private employment, the sharp rise in bankruptcies thereafter should have been expected. The model did overshoot the decrease in the bankruptcy rate after 1992.

Chart 7 compares the actual number of bankruptcies with the number projected in the out-of-sample forecast. By 1996, the model underpredicted the number of bankruptcies by approximately 400,000, or 40 percent. By either measure, the number of bankruptcies has exceeded the expected increase based on the factors explicitly modeled.

Conclusion

The primary goal of this paper was to explore the relationship between the U.S. personal bankruptcy rate and two factors thought to influence the bankruptcy rate — consumer indebtedness and the business cycle. Among the reasons that an increase in the number of bankruptcies has caused concern is that there appears to be a close relationship between the bankruptcy rate and the commercial bank consumer loan charge-off rate. A clearer understanding of the dynamics behind the bankruptcy rate, even at a highly aggregate national level, can provide information about likely future changes in the charge-off rate.

Table 5

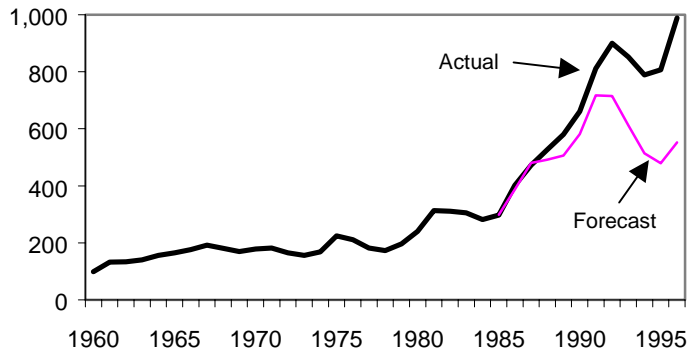
Sensitivity of Bankruptcy Model

Impact of One Std Deviation Increase in Explanatory Variable

Explanatory Variable	1996 Value	Standard Deviation	Chg in Number of Bankruptcies
CONSDEBT	11.175	0.779	166,868
MTGDEBT	5.800	0.950	178,800
EMPLOY	0.539	0.031	-185,995

Chart 7

Actual Number of Filings Above Forecasted Number
Thousands of Filings



Although consumer indebtedness and the business cycle explained about two-thirds of the change in the bankruptcy rate, the actual bankruptcy rate diverged from the expected rate beginning in the early 1990s. The large difference between the actual and expected bankruptcy rates suggests that there are other factors of importance. A brief list of factors cited by legal and economic analysts includes changes in the bankruptcy code, aggressive marketing of credit cards, and events such as prolonged illness or divorce. Arguing against the importance of several of these often-cited factors is that they have been prevalent in the national economy for many years while the results of the out-of-sample forecast suggest that the rise in bankruptcies has been well above expectation for only the past five or six years. Careful theoretical and empirical analysis is needed to determine which, if any, factors have gained in importance as an explanation of bankruptcy during the past few years.

Endnotes

¹ The bankruptcy rate is often quoted relative to the entire population, but a more representative measure is derived by limiting the population age group to those most likely to file — residents over 20 years of age. This definition of the bankruptcy rate will be used throughout this paper.

² Based solely on the concept of correlation, however, there is little insight about the expected change in the charge-off rate as a result of a given change in the bankruptcy rate. Ideally, the relationship between these two concepts could be more concisely evaluated by regressing changes in the charge-off rate on changes in the bankruptcy rate. Based on a simple regression and using annual frequency data for the period 1986 to 1996, a one-percentage point increase in the bankruptcy rates (as defined above) will result in an increase of about 0.68 in the charge-off

rate. Although these results are only suggestive, the most important conclusion is that there appears to be a statistically significant relationship between the bankruptcy rate and the charge-off rate. Even at a highly aggregate national level, a better understanding of the likely future course of the bankruptcy rate, including those factors that are important in explaining the movements in the bankruptcy rate, would aid in assessing the impact of bankruptcies on the national commercial bank consumer loan charge-off rate.

³ For a more detailed discussion of consumer debt measures, see Murray (1997).

⁴ See Kennickell, Starr-McCluer and Sunden (1997).

⁵ The non-uniform distribution of debt suggests that household financial risk may also influence the bankruptcy rate. Households generally accumulate debt more rapidly than wealth in the early years. This disparity between debt and wealth accumulation suggests that younger households may not be able to withstand events that result in financial distress as well as older households with more substantial wealth.

⁶ The Augmented Dickey-Fuller unit root test was performed on the levels and first differences of the dependent variable and each of the explanatory variables. In each case there was strong statistical evidence of the presence of a unit root and nonstationarity of the data.

Nonstationary time series are those that do not have a fixed mean or variance. Rather, the mean and variance of the time series is dependent on time. Stationarity of regressors is assumed in the derivation of standard inference procedures for regression models. Nonstationary regressors invalidate many standard results and require special treatment. Since many economic time series have a significant trend component, most economic series are not stationary in levels. Unit root tests are a class of statistical tests that can be used to determine whether a time series is stationary. If a time series is not stationary, then a transformation, such as differencing, can be used to induce stationarity. The Augmented Dickey-Fuller unit root test is one of several tests for nonstationarity. For a more detailed discussion, see Davidson and MacKinnon (1993, 700-705).

⁷ The specific lag structure in the equation was determined with reference to measures of model fit such as the Akaike Information Criterion.

⁸ Initial testing of the model found the presence of heteroskedastic residuals. Heteroskedasticity occurs when the size of the residuals in a regression is related to the size of the lagged residuals. Under these conditions, the usual computation of standard errors is invalidated and inferences based on these standard errors are also invalidated. One solution to the problem of heteroskedasticity is to transform the dependent and independent variables using a nonlinear function such as the natural log. In general, there may exist no transformation that eliminates heteroskedasticity, although there are many potential candidates for such a transformation. The natural log is a commonly used transformation and was sufficient to eliminate heteroskedasticity in the current model. As a result, all data used in the estimation are in log-differenced form.

⁹ Standard residual tests supported the hypothesis of normally distributed residuals and rejected the hypothesis of serial correlation and heteroskedasticity. To test the structural stability of the equations, a series of Chow Forecast tests was performed.

There was no statistically significant evidence of a change in structure or structural instability.

¹⁰ To correctly generate an out-of-sample forecast, it is necessary to re-estimate the model over the period prior to the forecast period — the period 1960-1986 in the current example. When this estimation is done, the following results are obtained:

Out-of-Sample Estimation Results

24 Periods, Annual (1960-1986)

Dependent Variable = BRUPT

Variable	Lag	Coefficient	Std. Error	t- Stat
CONSDEBT	1	2.7103	0.2824	9.598
MTGDEBT	2	1.7075	0.6143	2.780
EMPLOY	---	-3.5509	0.7661	-4.635
Constant	---	0.0297	0.0169	1.761
Adj R-square		F-statistic	D.W. Statistic	
0.6500		15.2400	1.9619	

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About the Author

Paul C. Bishop is an Economist in the Economic Analysis Section of the Division of Insurance.

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